Working in Open Innovation: How to Determine Networks and Their Relationship Using Techmining

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***Abstract*. This paper proposes how to foster open innovation through the establishment of collaborative networks. It displays how to elaborate and to visualize innovation networks existing through the analysis of the information contained in scientifical and technical databases. It comes to show two networks for innovation, made with text mining, the inventors network made upon information of the Intellectual property register and other network for innovation composed by authors of technical papers. These developments applying tech-mining techniques will allow companies to interact with numerous other companies and experts in every part of the world. Results can be of value to researchers, research managers, public institutions or decision makers in general who need to keep abreast of changing technical domains and anticipate future developments or establish for further knowledge transfer partnerships. The concept and application of open innovation and its collaborative networks will be integrated in the future innovation management systems.**

Keywords- Open-innovation, Tech-mining, R&D Management, Innovation, Collaborative Networks

I. OPEN INNOVATION APPROACH

The basic premise of open innovation is opening up the innovation processes. For that, studies of innovation [1,2] have pointed to the growing relevance of external sources of innovation. More than relying on internal research and development, R&D, everything indicates that greater results are obtained if the innovation effort is shared; this is the concept called "open innovation" or interactive innovation [3]. This innovation approach requires mastering new skills like the knowledge of the net of organizations that work in a field termed "networks for innovation" and the relevance of their relationships.

Open innovation grows from people working together on a mutually agreed-upon topic that inspires them. In a firm it's developed when the environment is favorable to the innovation. For this to occur, it is necessary to meet together: Complementary competences and excellence, transparent management and collaboration rules, and it is basic to use collaboration platforms. These collaboration platforms are a key tool for the development of the open innovation.

In order to make good decisions, for example investing in R&D it is essential to know what is happening in a technological field. Organizations increasingly rely on external sources of innovation specifically in science and technology works and projects [4] due to globalization. Technological management explains the generation of innovations from technological inputs [5]. In this function, together with conventional inputs, is included as indicator the existence of cooperative R&D agreements as a starting point for innovation.

Open innovation is bi-directional. Huizingh establishes that inbound open innovation refers to internal use of external knowledge, while outbound open innovation refers to external exploitation of internal knowledge. In the case of inbound open innovations, companies take advantage of external R&D to innovate in their products and services.

Several additional innovation approaches [6] reinforce the message that knowledge of external R&D is vital, and of course it is necessary to identify the authors, patent assignees and inventors in general players of these R&D. Follow up to the activities of said actors becomes part of the companies´strategy and establishing collaboration agreements could be the starting point for new innovations. Therefore the collaborative networks are the basis for future alliances.

Research in strategic alliances in R&D, focuses in the effects of university–industry links. Usually on innovation-specific variables such as patents or projects; however, the organizational dynamics of these relationships remain under-researched [7,8].

The most obvious external context characteristic is industry. In the case of Small-Medium Enterprises, have been defined two concepts. First is closed innovation, where the companies generate their own innovation ideas and they develop, build and market, distribute, service, finance and support them on their own [9] . Open innovation is just the opposite concept and takes place in terms of, for example, joint R&D, patenting and crowd sourcing. It is argued that 'open innovation' provides access to technologies, and modern laboratory facilities that take years and require major R&D investment to acquire in-house. Open innovation is increasingly receiving attention in academic research. Normally the existent investigation about open innovation is focused on high technology multinational firms or large companies. The importance of small and medium-sized enterprises (SMEs) in economic growth has made them a central element in much recent policymaking. Of particular interest is the ways in which SMEs innovate, and much recent policymaking has been directed at mechanisms to support this activity such us Knowledge Transfer Partnerships

This research was undertaken at University of the Basque Country drawing on support by Basque Government below the program SAIOTEK program. Ref: SA-2010-00049 MIN+ORG)

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(KTP), an agreement between companies and academic centers so that the former can access the knowledge created in investigative settings. It is another way to establish networks for innovation.

This paper explores the characteristics of collaborative relationships through cases and proposes how to foster open innovation through the establishment of collaborative networks.

II. SAMPLE

An exhaustive search was chosen and constructed with basic terms of the waste recycling sector to work with the largest possible sample. If the sample is very representative it is possible to infer all the players and their relationships. The following query was formulated for extracting records from the databases: KW=RECYCL* AND KW=WAST*

Thus the question is launched, first in the database Environmental Sciences and Pollution Management, belonging to the CSA (including scientific journals, conference proceedings, reports, monographs, books and government publications). Secondly, the industrial property sample is downloaded from the Derwent Innovation Index (DII) database. Once it is launched the search proceeds with its downloading and cleaning tasks, results were 28,323 records of registered industrial patents. The initial sample for the mining analysis can be observed on the following table:

TABLE I- Sample

RECYCLING WASTE SECTOR		
Number of registers	11677	28323
Database	CSA Environmental Sciences and Pollution Management	Derwent Innovation index
Supplier	Cambridge Scientifical Abstracts	Thomson Reuters
Short Description	Abstracts and citations are drawn from over 6000 serials including scientific journals, conference proceedings, reports, monographs, books and government publications	Patents from 40 patent-issuing authorities.

III. METHODOLOGY. CASE EXAMPLE

Nowadays the innovation is global and new developments are very geographically distributed. The web of contacts and collaborations does not understand Geographic boundaries, so it is necessary to study information coming from scientific and technological databases, with which a network of world experts can be created.

This analysis and the determination of the subsequent network can be performed using text-mining techniques applied on structured data. This paper presents two collaborative networks collected through text mining.

The first one is a web of collaborations between patent inventors, and the second is a web of collaborations between investigators, both cases in the field of waste recycling.

In the first case, the industrial property database is used, and the sample is downloaded from the Derwent Innovation Index (DII), belonging to the databases supplier Thomson Routers. Once the search step for the waste recycling sector is finished, it proceeds with the data download and import into the analysis soft tool and next with the data cleaning tasks. The results were 28,323 records of registered industrial patents to be analyzed.

We have applied the mining of this database with the help of the text-mining software tool called "Vantage Point1", and we have followed the methodology given by Zhu [10]. After the importing and cleaning, we did a bibliometric analysis to determine the activity measuring indicators such as the counts of publications or patents, the counts by institutions, or the source of publication. In a second step we tried to analyse the linkage measures, which are much more difficult to ascertain. Some of the results of these analyses presented 54% of patent assignees are companies, and there are 98 of them with more than 25 patents each, basically located in the Asian continent. Figure 1 is the Aduna cluster co-ocurrences map of the main inventors with more than 50 patents each and their relationships.

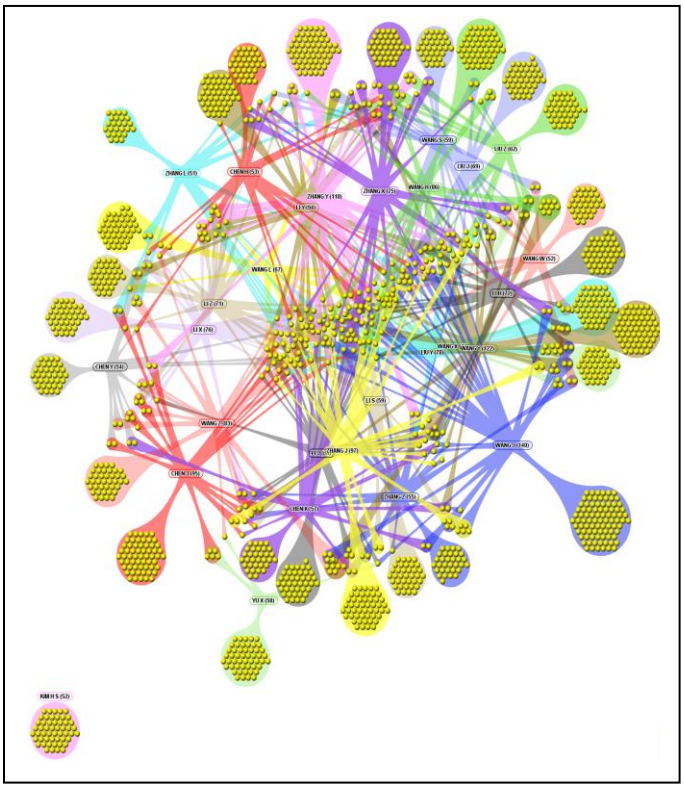

Fig 1. Inventors with more than 50 patents each

These 28 inventors, with more than 50 patents, are implicated in 1632 records. In the figure knots are records, individual patents.

[1] Software tool developed by Search Technology Inc.

Every record or patent can contain more than one inventor, and every inventor is connected, in the figure, to its patents by lines. Therefore, the inventors will be in the center of its patents.

The quantity of knots represented the amount of patents belonging to one inventor. The connection lines show the collaborations between the inventors.

Analyzing the connection lines is possible analyzed all the structure of the network, who are the main inventors, how many collaborations has everyone, in which areas..and so on. We can clearly find potential collaboration opportunities to establish an advanced network for innovation.

Observing the figure 1, one can notice a nucleus of inventors that form a hinge and collaborate with the remainders. That is to say that there is a group whose collaboration makes up the net's core competence. Through the visualization and analysis of the members of the network of innovation, a company can ascertain its principal knots at a World level.

In the second case we applied mining to articles and proceedings databases in order to establish the Innovation platform in the academic world. This step uses the CSA Environmental Sciences and Pollution Management database which belongs to Cambridge Scientific Abstracts, the same query was applied in waste recycling sector as in the first case and 11167 records were retrieved.

After mining this database, it is possible understand the structure of the knowledge field. Perhaps is more interesting focus in the core of the knowledge in waste recycling. For example, 43 authors who published more than 10 articles in the field were identified. Analyzing the contributions of these 43 authors can know that these articles have been published in 2054 journals which is necessary to read it. This may seem large, but we can state that it is possible to visualise 50% of the field of the knowledge using only 85 magazines and 25 % of the field of waste recycled can be analysed by making use of the first eight journals. To establish networks of collaboration we have also determined the 28 most prolific authors and the companies that each author worked for.

However in this second case we would like to show the result of other analyzed bigger to understand the structure of the networks for innovation. Figure 2 shows all the Aduna diagram of the top 200 hundred authors. In this figure it is possible to point out various networks of collaboration to be studied separately. There are groups of different size, individuals or little collaboration and others that it is possible called network.

The analysis denotes the existence of five collaborative networks signalled by circles and some other single entities whose collaborations are so scarce that we cannot incorporate them in an open innovation concept.

If these structures detected are crossed with the dates of their publications, we will be able to see that they can be grouped by decades. The group circled by one elipse centred around the one of the oldest authors, Goldstein, published during the last decade of the XX century. Nevertheless, the cluster of the left be made up of authors such as Graedel TE, (13 contributions) or Bertram Marlen (7 contributions), authors that start publishing from 2000 and, therefore, have a greater degree of novelty.

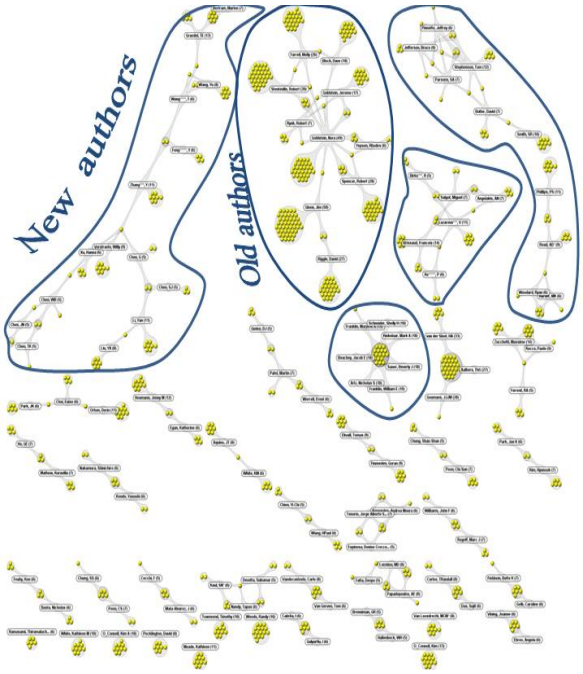

Fig. 2. Networks for innovation of top 200 authors

IV. CONCLUSIONS

Open innovation refers to internal use of external knowledge and this paper proposes how to foster open innovation through the establishment of collaborative networks.

It displays how to detect and to visualize innovation networks existing through the analysis of the information of R&D contained in scientifical and technical databases. The main patent-assignees, inventors and authors which shape the networks for innovations in the waste recycling sector were identified and their collaborations were as well established.

Developments in Tech-mining will allow companies to interact with numerous other companies and experts in every part of the world. Results can be of value to researchers, research managers, public institutions or decision makers in general who need to keep abreast of changing technical domains and anticipate future developments or establish for further knowledge transfer partnerships.

These results confirm that Tech-Mining is a suitable technique to satisfy the open-innovation requirement for identifying and optimizing the best potential partners and for choosing the right technological alternative.

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